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**I-33170 Pordenone(IT)**(54) **Gas-heated forced-convection oven.**

(57) Gas-heated forced-convection oven for cooking food through the fan-assisted circulation of hot air, which is heated up by a tubular conduit (15) arranged in the cooking cavity (5) of the oven, and/or by the injection of steam generated in a boiler (33) connected with said cooking cavity (5) of the oven, and/or through the combined action of mechanically circulated hot air and superheated steam.

Oven in which said tubular conduit (15), containing swirl baffle means (47) provided for turbulent flow, is connected with one of its ends to a plenum chamber (18) containing a burner (19) and adjoining a fan means (26) adapted to bring about a forced circulation of the flue gases through said tubular conduit before exhausting them.

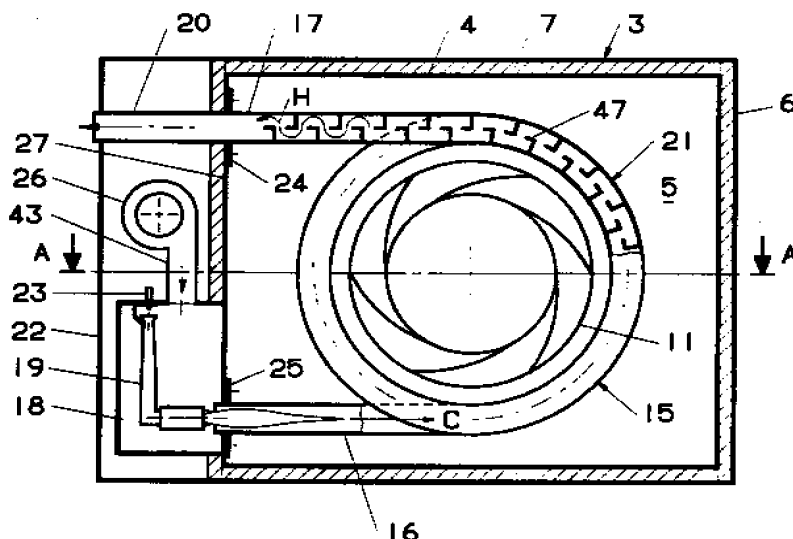


FIG. 1

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The present invention relates to a gas-heated oven for cooking food under the action of forced hot air circulation and the possible presence of steam in the cooking cavity of the same oven.

Gas heated ovens with forced hot-air convection for cooking food arranged inside a tightly sealed cooking cavity are known from the prior art, said ovens being further arranged to also cook the food through the action of steam that is generated in an appropriately provided, separate boiler and is then delivered into said cooking cavity through appropriately provided connection pipings.

In particular, these ovens essentially comprise a motor-driven fan and an arrangement of heating elements that are mounted against the back wall of said cooking cavity so as to bring about a flow of hot air through the same cooking cavity, said heating elements consisting of a plurality of parallel pipes extending over the whole height of the cooking cavity, through which the hot flue gases generated by a gas-fuelled atmospheric burner of the traditional type that is housed in a position underneath said cooking cavity.

Said pipes are so shaped as to include semi-circular portions located in close proximity of the outer profile of the blades of the wheel of said motor-driven fan, as well as two vertical, rectilinear portions that flow into the afore cited semi-circular portions and are respectively connected with the oven cooking cavity, which is located therebeneath and houses said gas-fuelled burner, and a flue exhaust riser provided in the upper portion of said cooking cavity.

In this way, ovens of the above described kind enable cooking of food to be performed in two different manners, ie. by roasting the food when the oven is set to operate so as to cook by forced hot-air circulation only, or by 'boiling' the food when said oven is set to operate so as to also cook by injecting steam into the cooking cavity.

However, all afore described ovens, while ensuring satisfactory food cooking performance, have a number of typical drawbacks.

First of all, there is in fact a drawback in connection with the presence of the burner which, being arranged in an underneath position in close proximity of the related end portions of the heat-exchanger pipes, causes both said end portions of the heat-exchanger pipes, which are mounted against the back wall of the cooking cavity of the oven, and the sheet-metal parts forming said back wall and the bottom wall of said cooking cavity to undesirably heat up to almost red-hot temperature.

Such an excessive heating up of said pipes and said sheet-metal sections causes in particular the whole metal structure of the cooking cavity of the oven to be subject to considerable thermal expansion effects, and may furthermore rapidly

lead to conditions jeopardizing the mechanical strength and integrity of the materials which said pipes and said sheet-metal sections are made of, with the possibility for the cooking cavity itself to undergo strain, deformation and structural impairments as a result thereof.

In addition to all that, the high temperature reached by the bottom wall of the cooking cavity of the oven, in the presence of food fat or grease particles that have fallen onto the bottom surface of the same cooking cavity, gives rise to heavy smoke development owing to the burning of that fat or grease build-up, whereas such smoke is most likely to impair the taste of the food being cooked.

Furthermore, the particular physical arrangement of the burner in the oven does not allow for more cooking ovens of this kind to be mounted upon each other in a multi-tier arrangement in the case that tight space reasons would make such an arrangement most advisable.

A further drawback of this kind of cooking ovens lies in the fact that they usually require the use of burners which are clearly oversized in comparison with the heat power rating that is actually required for food cooking purposes, since only a part of the thermal energy in the flue gases is in this case used to heat up the air circulated inside the cooking cavity of the ovens owing to the fact that said flue gases flow through the heat-exchanger pipes at a quite high rate, so that they are still relatively hot when they leave the heat-exchanger pipes, and that the same heat-exchanger pipes form a relatively limited heat-exchange surface area inside the cooking cavity.

Finally, the form of the heat-exchanger pipes, their being arranged closely spaced from each other, and in particular their being led to intersect with the bottom of the cooking cavity make it quite difficult to reach them conveniently for cleaning or other periodical maintenance purposes.

It is the purpose of the present invention to overcome all the afore cited drawbacks and limitations by providing an oven for cooking food by forced hot-air convection and/or steam injection into the cooking cavity of the same oven, said oven being arranged to cause the food to be heated up for cooking by means of forced circulation of air and/or steam that are in turn heated up in a heat-exchanger means which is shaped and arranged so as to ensure the highest possible heat-exchange efficiency.

Such an aim, as well as further purposes are reached according to the present invention in a gas-heated, forced-convection food cooking oven embodying the features as substantially described with particular reference to the appended claims.

Said features according to the invention will be further described by way of non-limiting example

with reference to the accompanying drawings in which:

- Figure 1 is a schematical view through the cross-sectioned front elevation of the cooking oven according to the invention;
- Figure 2 is a schematical view through the cross-sectioned top portion of the cooking oven according to the invention;
- Figure 3 is a view through the partially cross-sectioned front elevation of an enlarged constructional detail of the cooking oven according to the invention;
- Figure 4 is a perspective view of a further enlarged constructional item of the cooking oven according to the invention.

By having reference to these Figures, a gas-heated cooking oven 3 according to the present invention is described in the following, said oven being capable of being used in a preferred way in professional kitchens of such institutional catering establishments as hospitals, nursing homes, canteens, hotels, restaurants, etc.

In particular, such an oven comprises a metal muffle 4 having a box-like shape, open on its front side, and delimiting internally the cooking cavity 5 of the oven, and it further comprises an outer metal enclosure 6, which has also a box-like shape, is larger in its size than the afore cited muffle and encloses said muffle so as to define hollow spaces all around it, in which corresponding mats or plates 7 of insulating material of a traditional type are inserted.

The cooking oven according to the present invention further comprises a separate, thermally insulated door 8 provided to close the afore cited open front side of the muffle 4, said door being hinged on one side to said outer enclosure 6 and being further sized so as it is adapted to tightly fit and abut against a corresponding sealing gasket 9 attached along the whole perimetral rim of the front opening 10 in said outer enclosure 6, thereby shutting the cooking cavity 5 of the oven in a tightly sealed way.

Inside said cooking cavity 5 of the oven a fan means 11 of a traditional type is mounted, the driving shaft 12 of which is arranged to pass through an opening 13 provided in the back wall of the outer enclosure 6 and can be rotatably driven by an electric motor 14 of a traditional type which is supported against the outer surface of said back wall.

It is the purpose of said fan means 11 to promote cooking of the food placed in the cooking cavity 5 of the oven by forced convection, ie. by bringing about a mechanical circulation of the air heated by at least an appropriate heat-exchanger arrangement 15 mounted inside said cooking cavity and consisting of a tubular conduit wound in a

spiral-like way around said fan means 11 so as to form a sequence of coils having preferably a circular shape.

Said tubular conduit is in particular provided at its ends with corresponding rectilinear, horizontal portions 16 and 17, of which portions the portion 16 is communicating with a box-like portion 18 that is attached externally on one of its sides against the outer enclosure 6 of the oven, and forms a plenum chamber in which a gas burner 19 is housed, whereas the other portion 17 goes out horizontally towards the lateral side of the oven, thereby defining a rectilinear, horizontal portion 20.

The afore cited tubular conduit is furthermore provided with a central portions 21 that is shaped in the form of a spiral with such a bending radius as to enable said central portion to be fittingly arranged all around said fan means 11, at a relatively small distance from the outer contour of the wheel of said fan means.

Said tubular conduit 15 is mounted in the cooking oven according to the present invention by first introducing and placing it in position inside the cooking cavity 5, and then inserting its ends through corresponding openings that are provided in the side wall 27 of the oven, in such a way as to have said tubular conduit fixed to that side wall by means of the flanges 24, 25 that are integrally fitted on said rectilinear, horizontal portions 17 and 16 of the conduit and are to be connected with said rectilinear, horizontal portions 20 and said plenum chamber 18, respectively (see Figure 1).

Furthermore, with said tubular conduit installed in its due position in the oven cavity, the central portion 21 thereof becomes arranged all around the fan means 11 at a relatively small distance with respect to the back wall of the enclosure 6 of the oven (see Figure 2).

In correspondence of the side wall of the oven supporting the tubular conduit 15 in the afore described way, an enclosed space 22 is in turn provided, which is attached laterally to the same wall of the oven and is adapted to accomodate: a steam generator means 33, the plenum chamber 18, a fan means 26 and the various control and regulation devices (not shown) required in connection with said fan means.

As far as it is concerned, the gas burner 19 arranged in the combustion chamber 18 is in a preferred way of a torch-like type (see Figure 3) and consists of a Venturi pipe 34 that, after a 90-degree bend, connects into a rectilinear pipe portions 35, in the surface of which a plurality of perforations 36 are provided, distributed all over its circumference according to a regular patterns.

Said perforated pipe portion 35 is in turn enclosed externally by a further pipe portion 37 which builds with said first pipe portion 35 a hollow cavity

38 that is sealed, on one of its ends, by the wall 39 connected with said further pipe portion 37.

Furthermore, said burner 19 is connected in a *per se* known way with the gas supply conduit 23 which is terminated by the provision of an injector 40 that is coincident with and located in close proximity of the inlet port 41 of said Venturi pipe 34.

The cylindrical head 42 of the burner 19, as defined by said pipe portion 37, is arranged so as to fall coaxially with and be turned towards the rectilinear portion 16 of said tubular conduit 15, so that the flue gas resulting from the combustion, and used to heating purposes, are allowed to circulate through said tubular conduit.

The combustion chamber 18 is connected to communicate with the delivery side 43 of the fan means 26 which, when the burner is operating, ensures the delivery of the correct amount of air required for complete combustion and further promotes the forced circulation of the flue gases through said tubular conduit 15 and causes the same flue gases to be then exhausted through the horizontal portion 20 of said tubular conduit.

In particular, the action of said fan means 26, which takes in the air from said enclosed space 22, creates inside the afore cited plenum chamber 18 the overpressure condition which is required to overcome all kinds of flow-dynamic resistances that flue gases may be likely to encounter when flowing through the whole length of said heat-exchanger arrangement.

Inside said plenum chamber 18, the jet of gas delivered by said injector 40 and directed into said Venturi pipe 34, causes a certain amount of primary air to be admitted into the same Venturi pipe 34 (in the direction shown by the arrow E), so that it is capable of pre-mixing with the gas, thereby forming an air-gas mixture that flows towards the outlet port 44 of the cylindrical head 42 of the burner 19, where it is ignited so as to start combustion and give rise to the flame.

Most of said air-gas mixture reaches the outlet port 44 directly, where it originates the main flame 45, by flowing through the pipe portion 35, whereas the remaining part of said mixture passes through the ports 36, following the direction indicated by the arrow F, and then, through the hollow cavity 38, it flows towards said outlet port 44 where it originates a very short, annular flame 46, which acts as a retention flame for stabilizing said main flame 45 and preventing it from lifting.

In addition to that, complete combustion is also ensured by a further amount of air (secondary air) which flows in according the direction shown by the arrow G, thereby investing the flame annularly.

The resulting cooking oven according to the present invention is further provided with a plane

partition wall 28 arranged inside the cooking cavity 5 of the oven (see Figure 2), said partition wall being applied in front of the fan means 11 and the coils of said tubular conduit 15 so as to delimitate, within said cooking cavity, a separate chamber 29 having a limited volume and enclosing said fan means and said tubular conduit.

Furthermore, said partition wall 28 is sized so as it extends over almost the whole width of the cooking cavity 5, thereby defining corresponding apertures 30 and 31 at its sides for allowing the hot air to pass through in the direction indicated by the arrows D. It is further provided with a central aperture 32 with its edge folded towards said separate chamber 29, in correspondence of the wheel of said fan means 11, to the purpose of enabling said fan means to take in the air to be subsequently heated up and circulated inside the cooking cavity of the oven.

Finally, the afore illustrated cooking oven according to the present invention can be also arranged to cook food by means of steam injection into said cooking cavity 5, said steam being generated in a *per se* known manner in the afore cited steam generator which in a preferred way consists of a separate boiler 33 provided in said enclosed space 22 and connected with said cooking cavity 5.

The advantages of the cooking oven according to the present invention, which can be used to cook food either by roasting or baking through forced circulation of hot air only, ie. excluding steam injection in the cooking cavity 5, or by steaming through the injection of steam in said cooking cavity, and excluding hot air circulation therein, or again by combined roasting and steaming through the mixed action of hot air circulation and steam injection, are at this point clearly apparent.

First of all, in fact, it will be appreciated that the presence of the fan means 26 in correspondence of the inlet port of said tubular conduit 15 enables a forced circulation of the flue gases through the same tubular conduit to be brought about in a very effective way. Furthermore, the efficiency at which the resulting heat-exchange process takes place between the flue gases and the air in the cooking cavity of the oven can be additionally enhanced through the provision, in the terminal portion 17 of said tubular conduit 15, of at least a swirl baffle (47) of a *per se* known shape, provided to create turbulent flow and consisting for instance in a plane sheet-metal strip 48 (see Figure 4), which is inserted in the tubular conduit 15 and in which regularly spaced rectangular apertures 48a are provided, having rectangular cut-away portions 49 which are bent, for instance orthogonally with respect to said plane sheet-metal strip 48 and alternately projecting from the opposite sides thereof, so as to define in this way a labyrinth flow path for

a part of the flue gases circulating in the tubular conduit 15 to flow through according to a S-shaped flow pattern as indicated by the arrow H, thereby causing the turbulence in the flow of said flue gases to be increased and, as a result, the heat-exchange coefficient to be improved.

A first advantage of this tubular conduit lies in the fact that it is very simple in its construction, so that it is capable of being mounted and assembled in the oven in a very simple and quick way, as well as capable of being reached in a appropriately convenient way for cleaning and other periodical maintenance purposes.

In addition to all that, said tubular conduit 15 is capable of freely expanding under the influence of the various operating temperatures of the oven, whereas it avoids transmitting such thermal expansion effects on to the other walls of the oven owing to both the particular spiral-like configuration of said tubular conduit and the fact that it is only and solely supported in correspondence of a single wall of the oven, so that it has no physical contact with any other wall of the same oven.

Furthermore, the fact that the burner is arranged laterally with respect to the oven and the flue gas exhaust is provided at the side of the oven outer enclosure means that there is the possibility for two or more ovens of this kind to be stacked whenever space considerations make this necessary or appropriate.

Finally, should a need arise, the gas-heated cooking oven according to the present invention can quite quickly and simply be converted into an electrically heated oven by removing the tubular conduit 15 from its mounting position in the oven and replacing it with a corresponding spiral-like coiled electric heating element of a traditional type, which is to be mounted in the oven according to the same criteria and with the same methods as previously described.

This fact, therefore, enables gas and electric cooking ovens to be manufactured starting from a single and common constructive structure in which said tubular conduit or said electric heating element can alternatively be installed in accordance with the actual needs.

It will be appreciated that the above described cooking oven according to the invention may be the subject of any such modification as considered to be appropriate, such as for instance by giving said tubular conduit 15 a different geometric shape that would anyway ensure an efficient forced circulation of flue gases through said conduit, or by providing said plenum chamber 18 with a different type of burner, without departing from the scopes of the invention.

## Claims

1. Gas-heated forced-convection oven for food cooking purposes, comprising at least a fan and heat-exchanging means arranged inside the tightly closable cooking cavity of the oven, as well as possibly comprising at least a steam generator of a traditional type connected with said cooking cavity so as to enable the food to be cooked through the injection of steam into said cooking cavity, said heat-exchanging means being arranged to allow the flue gases of at least a gas-fuelled burner of a traditional type to flow therethrough and being further connected with an aperture provided in said oven for exhausting said flue gases, **characterized in that** said heat-exchanging means consist of at least a spirally coiled tubular element (15) being preferably circular in its shape and applied inside said cooking cavity (5) near said fan means (11), said tubular conduit (15) being associated with flow diverting means (47) adapted to deviate the circulation of the flue gases and improve the heat-exchange process thereof, and **characterized in that** it comprises blowing means (26) associated with said gas-fuelled burner (19) and adapted to generate a blowing action to promote said forced circulation of the flue gases through said tubular conduit (15) as well as the subsequent outlet of the same flue gases through said flue gas exhaust aperture.

2. Gas-heated forced-convection oven according to claim 1, **characterized in that** said flow diverting means comprise at least a turbulence-promoting baffle means (47) provided with at least a plane sheet-metal strip (48) which is inserted in said tubular conduit (15) and provided with apertures (48a) having cut-away portions (49) which are bent orthogonally with respect to said plane sheet-metal strip (48) and alternately projecting from the opposite sides thereof, thereby defining a labyrinth-shaped flow path adapted to deviate the circulation of the flue gases through said tubular conduit (15).

3. Gas-heated forced-convection oven according to claim 1, **characterized in that** said blowing means comprise at least a fan means (26) communicating with a plenum chamber (18) housing said gas-fuelled burner (19), said chamber being provided laterally with respect to the main body of the oven and being mounted in a corresponding enclosed space (22) on one side of the same oven.

4. Gas-heated forced-convection oven according

to claim 3, **characterized in that** said gas-fuelled burner (19) consists of a torch-like burner comprising a Venturi pipe (34) turned toward the gas supply conduit (23) and connected orthogonally with a rectilinear pipe portion (35), which is provided with perforations (36) in its surface and is enclosed externally by a further pipe portion (37) defining a cylindrical burner head (42) which is arranged coaxially with respect to and turned toward the corresponding inlet end (16) of said tubular conduit (15).

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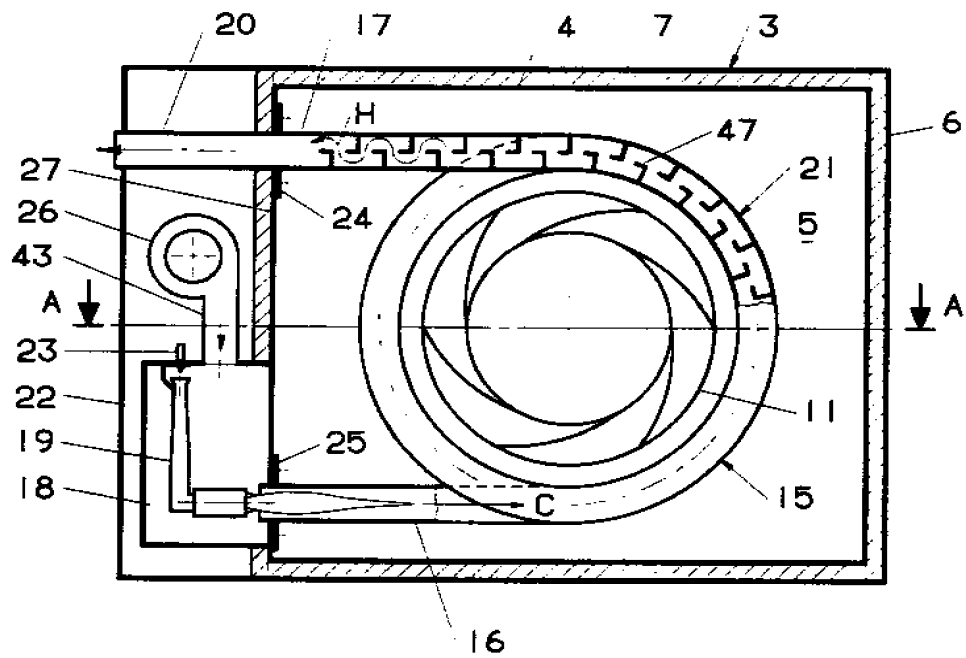


FIG. 1

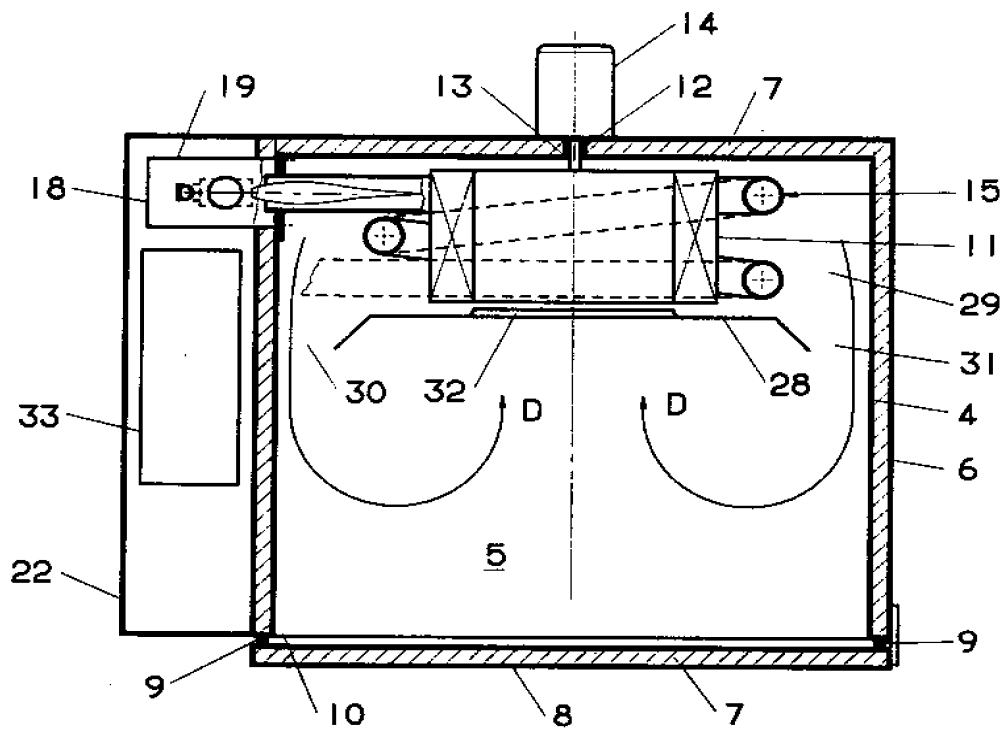


FIG. 2

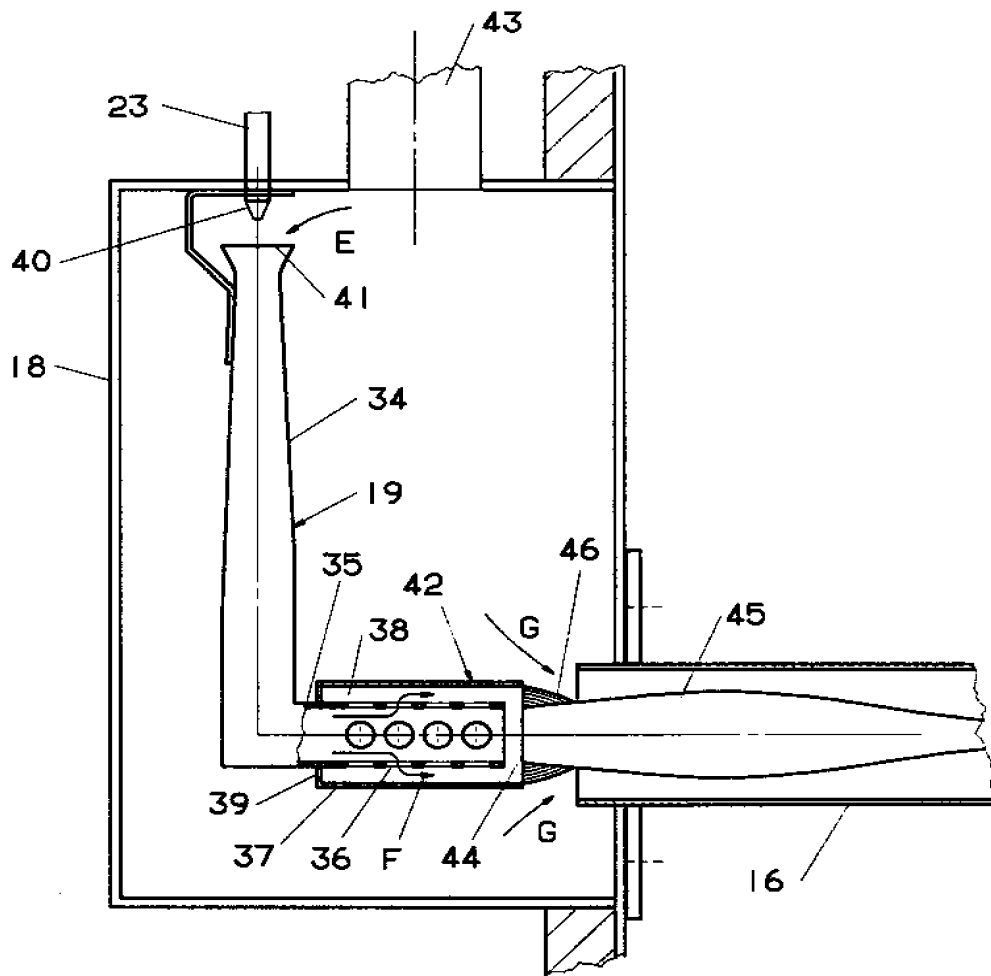


FIG. 3

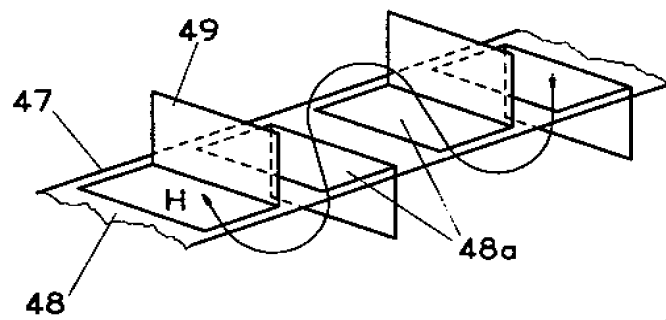


FIG. 4